

### 33.

## Mortality Statistics for Specimens in the New York Aquarium, 1939.

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(Plates I-III).

#### INTRODUCTION.

Approximately 1,600 specimens which died in the New York Aquarium during 1939 were examined to determine the cause of death. These are listed in Tables I to IV. A large number of specimens, especially fishes, which are being collected more or less continually for food and which also become part of the exhibition, are not included in this report. Such forms represent about 30% of the total population as given in the annual census. Also not included are those specimens which died immediately after their arrival; when large collections are made, from 20% to 30% usually survive long enough to become part of the Aquarium's exhibited population. However, in smaller, more selected collections, as much as 90% or more may survive. It should be remembered that aquatic species of animals, especially fishes, are difficult to handle and that those factors which tend to weaken them, *e.g.*, netting, transportation, change of water, also tend to lower their resistance to infective agents.

It is now pretty well established that host specificity among fishes and their parasites is the exception rather than the rule. One thing is certain—that under aquarium conditions such a relationship, if it exists at all, soon ceases to be, and may even take on an epidemic form, as in several cases reported here. In addition, it is known that infective agents tend to become more virulent in their effects when established on "abnormal" hosts.

Insofar as aquatic animals are concerned, the most virulent of the parasitic diseases are usually caused by external parasites, either protozoan or metazoan (flukes and copepods) living for the most part on the skin, eyes and gills.

It is very difficult in many instances to separate the primary from the secondary causes of death. For example, the primary cause which lowers the resistance of a given specimen may be a physical (such as fighting), chemical (changes in the water), or physiological (humoral or nutritional) one. If any of these adverse factors is sustained long enough, death follows; infective agents in such an instance may be but a secondary cause which only speeds up the demise.

The histo-pathology of the lesions produced by the various diseases has been, or will be, reported from time to time and therefore is not included in this report.

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## CAUSES OF DEATH OF MARINE FISHES. TABLE I.

The great majority of the marine fishes were kept in a closed circulating system; some of the local species, however, were maintained in water pumped from the adjoining bay. This is the principal reason why more than half of the deaths of marine fishes resulted from infectious and parasitic diseases (Table V). The largest number of these was due to *Oodinium ocellatum*. This protozoan parasite was first observed in the New York Aquarium in 1935 (Nigrelli, 1936). At that time the fishes harboring it were indigenous to Sand Hook Bay. During 1939 the infection appeared on fishes collected from Florida, especially in those forms belonging to the families Lutianidae and Haemulidae. It is interesting to note that *Oodinium ocellatum* was first described from West Indian fishes kept in the London Aquarium. We have had an opportunity to study the organism from fishes of both regions and have come to the conclusion that the parasite is the same.

Among Sandy Hook Bay fishes a new protozoan parasite made its appearance in 1939. The life-history studies of this *Trichodina* were reported by Padnos (1939a and b). The parasite is found in large numbers on the gills of the common puffer and to a lesser extent on other species. The incidence of infection in puffers from Sandy Hook Bay is very high and studies indicate that these fish may be a potential source of infection of this and other parasitic diseases.

In previous years, *Epibdella melleni*, a monogenetic trematode, was the major cause of deaths of marine fishes, especially those belonging to the spiny-rayed group (Nigrelli & Breder, 1934). In 1939 most of the fishes infected belonged to the families Lutianidae, Haemulidae and Chaetodontidae. The latter includes some of the handsomest of all West Indian fishes, but is most susceptible to this trematode. Various techniques, however, are employed to keep this parasite under control, as well as other monogenetic trematodes of less importance, such as *Microcotyle* and *Diplectanus*. The life-history of *Microcotyle* and *Diplectanus* is being studied by Paul (1939).

One of the most interesting, but less devastating, of infectious diseases is lymphocystis (Nigrelli & Smith, 1939). This condition has been attributed to a virus causing tremendous hypertrophy of cells of connective tissue origin. The condition is usually limited to such cells in the skin and fins, but in more severe instances hypertrophied cells have been found in the spleen, gastro-intestinal tract and ovaries. Insofar as could be determined, no cellular disease of this type has been reported for man.

The largest number of mortalities attributed to parasitic and infectious diseases in marine fishes occurred during the months of July and August (Table VI), soon after the arrival of a large collection from Florida. As was stated in the Annual Report of the Zoological Society (Nigrelli, 1940a), the rate of mortality is far greater in recently arrived specimens.

One disease about which we as yet know nothing, although it was sporadic in occurrence, involves a peculiar ulceration of the skin around the mouth and the fins. Plate I, Figs. 1 & 2, shows a queen triggerfish with this affliction. The condition is first made evident by sores around the mouth, which continue to spread, resulting eventually in a sloughing off of tissues in this region; later the fins become involved, there being an intense inflammation of the skin at their bases. Biopsied and autopsied material failed to reveal the presence of a causative agent. The internal organs were normal to all appearances, but in most cases the optic nerves were inflamed and the optic muscles completely atrophied.

About 20% of the deaths of marine fishes resulted from non-infectious diseases, with a variety of causes and occurring throughout the year. Most of these diseases affected fishes which had been on exhibition for more than one year, and are of the type, with rare exceptions, that normally would be expected among any animal population of similar proportions and under

conditions of confinement. Some of these may be of parasitic origin, although no causative agents have been recovered; others may be entirely humoral or nutritional. The above remarks also hold for those non-infectious deaths among the other two groups of fishes.

Fishes are susceptible to relatively slight adverse changes in the physical, chemical and thermal conditions of their environment—some more so than others, but all to a certain degree. Therefore it is not surprising to find that a number of specimens succumbed as a result of such changes. The Elasmobranchs are particularly sensitive to changes in specific gravity, for example.

#### CAUSES OF DEATHS OF TEMPERATE FRESH-WATER FISHES. TABLE II.

A lower mortality rate occurred among the temperate fresh-water fishes. This may be attributed for the most part to the fact that these fishes were kept in an open circulation for most of the year. Any infection on one specimen was usually limited to that individual or perhaps its tank-mates. The present closed circulation was put into operation in October, 1939. However, the increase in mortality during the last two months of the year resulted from the influx of a large collection from Illinois, rather than the effects of the closed circulation (Table VI).

The largest number of deaths among this group was caused by *Ichthyophthirius multifiliis*, a well known and at times very virulent protozoan parasite. More than three-quarters of the deaths reported from this cause, however, occurred in one species of catfish. These fish were from one to two inches long and were confined in a single tank.

*Saprolegnia* only attacks fresh-water fishes which have been injured either mechanically or by parasites. Handling thus presents a constant hazard, since spores of this fungus are omnipresent.

Among helminth infections, some losses were attributed to worms belonging to the monogenetic trematode group referred to as Gyrodactyloides. These are skin and gill parasites, and a large number of species have been reported from fresh-water fishes. They constitute the most dreaded parasite in aquarium and hatchery management, often causing the loss of great numbers of specimens.

The disease referred to as Myxomata is very interesting and in all probability of parasitic origin. The general effects of any of the external parasites is to produce an irritation of the skin which results in an excessive production of mucus, the most important protective mechanism of fishes. Sometimes a translucent, soft growth remains, covering the whole fish or parts of it. This growth is microscopically seen to be composed of stellate-shaped connective tissue cells. One difference between this type of tumor and those of similar nature reported for man and other mammals is that the myxomata in the latter are richly supplied with capillaries.

The number of deaths recorded under Temperature is almost entirely accounted for by losses incurred among the trouts during the summer months. Mortalities recorded under Chemical Poisoning refer to a single species. A tank of muskellunge on open circulation was treated for a slight infection of *Ichthyophthirius* with a protein—silver salt, a compound continually used for such purposes. A chemical interaction between this chemical and the chlorine in the water at that time resulted in the formation of silver chloride, a highly toxic substance to fishes.

#### CAUSES OF DEATH OF FRESH-WATER TROPICAL FISHES. TABLE III.

These comprise some of the smallest of fishes, and it is consequently very difficult to perform adequate autopsy. For this reason, many deaths resulting from undetermined causes are listed here.

It is known among ecologists, aquarists and tropical fish fanciers that fishes living in small standing bodies of water alter the chemical content of their environment, apparently not only making it more suitable for themselves, but sometimes rendering it completely unsuitable for even rather closely related species. This has been called water conditioning. It is a very important factor in the maintenance of tropical fish, and a very large portion of the 23% of deaths recorded under Acclimatization resulted from these small fishes being unable to adjust themselves satisfactorily to a new aquatic environment. Just what this conditioning is has so far evaded successful analysis. Evidence indicates that some specific animal proteins may be involved.

Because these fishes are kept in completely separated tanks, the incidence of infectious disease is practically negligible.

#### CAUSES OF DEATH OF REPTILES. TABLE IV.

The largest number of deaths among reptiles was attributed to a general enteritis. Just what was producing this condition in the Aquarium specimens has not been determined. Since no parasitic infection was evident, it is altogether possible that the condition may be nutritional.

The most interesting of reptilian diseases so far studied is the one developed by large alligators, previously reported as fatty degeneration (Nigrelli, 1940a). Large deposits of encapsulated fatty substance may be found just beneath the skin; between layers of muscles (Plate III, Fig. 7) and possibly extending into muscular tissues; between the muscles and the peritoneum, lying just outside the latter; and also inside the peritoneal cavity. There are indications that organs may be involved, too. Animals suffering from this disease may lie in the pools for weeks, refusing all food. Just before death they may have one or more severe hemorrhages through the snout, mouth or anus.

#### CAUSES OF DEATH OF INVERTEBRATES. TABLE IV.

Although the great majority of invertebrates on exhibition were not autopsied, it is definitely known that these creatures are extremely sensitive to changes in the chemical composition of the water about them, Table V. Thus it is believed that the small sample autopsied does not at all exaggerate the importance of this factor as a cause of death.

TABLE I.

#### Causes of Mortality in Marine Fishes.

DISEASE	FISH	No. DEATHS
<i>Oodinium ocellatum</i> Brown 32.6% <sup>1</sup>	Holocentridae	
	<i>Holocentrus ascensionis</i> (Osbeck), Squirrelfish	5
	Cheilodipteridae	
	<i>Apogon maculatus</i> (Poey), Spotted Cardinal Fish	5
	Serranidae	
	<i>Centropristus striatus</i> (L.), Sea Bass	9
	<i>Epinephelus adscensionis</i> (Osbeck), Rock Hind	2
	<i>Epinephelus morio</i> (C. & V.), Red Grouper	4
	<i>Petrometopon cruentatus</i> (Lac.), Graysby	1
		6

<sup>1</sup> Percentage of total number of recorded deaths.

<i>Rypticus saponaceus</i> (B. & S.), Soapfish	1
Lutianidae	
<i>Lutianus analis</i> (C. & V.), Muttonfish	2
<i>Lutianus apodus</i> (Walbaum), Schoolmaster	7
<i>Lutianus griseus</i> (L.), Gray Snapper	4
<i>Lutianus jocu</i> (B. & S.), Dog Snapper	2
<i>Lutianus synagris</i> (L.), Spot Snapper	9
<i>Ocyurus chrysurus</i> (Bloch), Yellowtail	17
Haemulidae	
<i>Anistoremus virginicus</i> (L.), Porkfish	40
<i>Haemulon album</i> C. & V., Margate Fish	1
<i>Haemulon flavolineatum</i> (Desmarest), Yellow Grunt	15
<i>Haemulon macrostomum</i> Gthr., Gray Grunt	5
<i>Haemulon plumieri</i> (Lac.), White Grunt	8
<i>Haemulon sciurus</i> (Shaw), Blue-striped Grunt	18
<i>Haemulon</i> sp., Iron Grunt	1
Sciaenidae	
<i>Eques acuminatus</i> (B. & S.), Cubbyu	4
<i>Menticirrhus saxatilis</i> (B. & S.), Northern Kingfish	6
Pomacentridae	
<i>Abudefduf saxatilis</i> (L.), Sergeant-major	2
<i>Dascyllus aruanus</i> (L.), Jesuite	8
Scaridae	
<i>Scarus caeruleus</i> (Bloch), Blue Parrotfish	10
Chaetodontidae	
<i>Angelichthys isabelita</i> Jordan & Ritter, Blue Angelfish	4
<i>Pomacanthus arcuatus</i> (L.), Black Angelfish	23
<i>Pomacanthus paru</i> (Bloch), French Angelfish	12
Acanthyridae	
<i>Acanthurus caeruleus</i> B. & S., Blue Tang	6
<i>Acanthurus hepatus</i> (L.), Doctorfish	2
Balistidae	
<i>Balistes vetula</i> L., Queen Triggerfish	4
Ostraciidae	
<i>Lactophrys trigonus</i> (L.), Common Trunkfish	9
Tetraodontidae	
<i>Spheroides maculatus</i> (B. & S.), Puffer	23
Diodontidae	
<i>Chilomycterus schoepfi</i> (Walbaum), Spiny Boxfish	17
<i>Didon hystrix</i> L., Porcupine Fish	2
Triglidae	
<i>Prionotus carolinus</i> (L.), Carolina Sea Robin	8
<i>Prionotus</i> sp., Blue-winged Sea Robin	2

<i>Trichodina</i> sp. 10.3%	Carangidae			
		<i>Caranx crysos</i> (Mitch.), Hard-tailed Jack	9	
	Serranidae			
		<i>Centropristus striatus</i> (L.), Sea Bass	5	
		<i>Roccus lineatus</i> (Bloch), Striped Bass	3	
	Sparidae			
		<i>Stenotomus chrysops</i> (L.), Porgy	2	
	Sciaenidae			
		<i>Menticirrhus saxatilis</i> (B. & S.) Northern Kingfish	7	
	Tetraodontidae			
		<i>Spheroides maculatus</i> (B. & S.), Puffer	43	
	Diodontidae			
		<i>Chilomycterus schoepfi</i> (Walbaum), Spiny Boxfish	12	
	Triglidae			
		<i>Prionotus carolinus</i> (L.), Carolina Sea Robin	6	
		<i>Prionotus evolans</i> (L.), Striped Sea Robin	8	
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	<i>Epibdella melleni</i> MacCallum 17.9%	Holocentridae		
			<i>Holocentrus ascensionis</i> (Osbeck), Squirrelfish	2
		Carangidae		
		<i>Vomer setapinnis</i> (Mitch.), Moonfish	4	
Serranidae				
		<i>Cephalopholis fulvus</i> (L.), Coney	1	
		<i>Dermatolepis marmoratus</i> Osburn & Mobray, Marbled Grouper	1	
		<i>Epinephelus adscensionis</i> (Osbeck), Rock Hind	1	
		<i>Mycteroperca interstitialis</i> (Poey), Princess Rockfish	2	
Lobotidae				
		<i>Lobotes surinamensis</i> (Bloch), Tripletail	1	
Lutianidae				
		<i>Lutianus analis</i> (C. & V.), Muttonfish	5	
		<i>Lutianus apodus</i> (Walbaum), Schoolmaster	1	
		<i>Lutianus griseus</i> (L.), Gray Snapper	1	
		<i>Lutianus jocu</i> (B. & S.), Dog Snapper	1	
		<i>Lutianus synagris</i> (L.), Spot Snapper	5	
		<i>Ocyurus chrysurus</i> (Bloch), Yellowtail	1	
Haemulidae				
		<i>Anistoremus virginicus</i> (L.), Porkfish	26	
		<i>Haemulon flavolineatum</i> (Demarest), Yellow Grunt	2	
		<i>Haemulon macrostomum</i> Gthr., Gray Grunt	10	
		<i>Haemulon plumieri</i> (Lac.), White Grunt	1	
		<i>Haemulon sciurus</i> (Shaw), Blue-striped Grunt	3	

	Sparidae	
	<i>Salema rhomboidalis</i> (L.), Salema	1
	Sciaenidae	
	<i>Pogonias cromis</i> (L.), Sea Drum	1
	Labridae	
	<i>Bodianus rufa</i> (L.), Spanish Hogfish	5
	<i>Julis pavo</i> (C. & V.), Swallow-tailed Wrasse	3
	<i>Lachnolaimus maximus</i> (Walbaum), Hogfish	16
	<i>Trechocopus scrofa</i> (C. & V.), Pink Wrasse	3
	Ephippidae	
	<i>Chaetodipterus faber</i> (Broussonet), Spadefish	5
	Chaetodontidae	
	<i>Angelichthys ciliaris</i> (L.), Queen Angelfish	4
	<i>Angelichthys isabelita</i> Jordan & Ritter, Blue Angelfish	29
	<i>Angelichthys townsendi</i> Nichols & Mowbray, Townsend's Angelfish	1
	<i>Chaetodon capistratus</i> L., Four-eyed Butterflyfish	5
	<i>Chaetodon collaris</i> Bloch, Lattice-work Fish	3
	<i>Chaetodon ocellatus</i> Bloch, Common Butterflyfish	3
	<i>Heniochus acuminatus</i> (L.), Long-finned Butterflyfish	1
	<i>Platax</i> sp., Sea Bat	1
	<i>Pomacanthus arcuatus</i> (L.), Black Angelfish	7
	Acanthyridae	
	<i>Acanthurus hepatus</i> (L.), Doctorfish	3
	Balistidae	
	<i>Balistes carolinensis</i> Gmelin, Common Triggerfish	2
	<i>Balistes vetula</i> L., Queen Triggerfish	1
	<i>Canthidermis sabaco</i> Poey, Ocean Triggerfish	4
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<i>Microcotyle</i> sp. .76%	Chaetodontidae	
	<i>Chaetodon capistratus</i> L., Four-eyed Butterflyfish	2
	<i>Chaetodon collaris</i> Bloch, Lattice-work Fish	3
	<i>Chaetodon pictus</i> Forskål, Striped Butterflyfish	1
	<i>Holocanthus tricolor</i> (Bloch), Rock Beauty	1
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<i>Diplectanus</i> sp. .54%	Pomacentridae	
	<i>Abudefduf saxatilis</i> (L.), Sergeant-major	1
	Tetraodontidae	
	<i>Tetraodon fluviatilis</i> (Buch.), Fresh-water Puffer	4

Lymphocystis .43%	Pomacentridae	
	<i>Amphiprion percula</i> (Lac.), Clownfish	1
	Chaetodontidae	
	<i>Angelichthys isabelita</i> Jordan & Ritter, Blue Angelfish	2
	Monacanthidae	
	<i>Ceratacanthus schoepfi</i> (Walbaum) Orange Filefish	1
Ulceration of skin and fins .54%	Kyphosidae	
	<i>Kyphosus sectatrix</i> (L.), Bermuda Chub	2
	Ephippidae	
	<i>Chaetodipterus faber</i> (Broussonet), Spadefish	1
	Balistidae	
	<i>Balistes vetula</i> L., Queen Triggerfish	2
Trematode enteritis 1.30%	Holocentridae	
	<i>Holocentrus ascensionis</i> (Osbeck), Squirrelfish	2
	Carangidae	
	<i>Caranx hippos</i> (L.), Common Jack	1
	Serranidae	
	<i>Centropristus striatus</i> (L.), Sea Bass	1
	<i>Epinephelus morio</i> (C. & V.), Red Grouper	1
	<i>Mycteroperca bonaci</i> (Poey), Black Grouper	2
	<i>Roccus lineatus</i> (Bloch), Striped Bass	1
	Lutianidae	
	<i>Ocyurus chrysurus</i> (Bloch), Yellowtail	2
	Scorpaenidae	
	<i>Scorpaena madurensis</i> (C. & V.), Madeira Scorpionfish	2
Cestode enteritis .65%	Galeidae	
	<i>Carcharhinus milberti</i> Müller & Henle, Ground Shark	2
	Acipenseridae	
	<i>Acipenser oxyrinchus</i> Mitch., Common Sturgeon	2
	Carangidae	
	<i>Caranx crysos</i> (Mitch.), Hard-tailed Jack	1
	Triglidae	
<i>Prionotus carolinus</i> (L.), Carolina Sea Robin	1	
Protozoan enteritis .11%	Diodontidae	
	<i>Chilomycterus schoepfi</i> (Walbaum), Spiny Boxfish	1
Gastritis 2.49%	Ginglymostomidae	
	<i>Ginglymostoma cirratum</i> (Bonnaterre), Nurse Shark	1



	Acipenseridae	
	<i>Acipenser oxyrinchus</i> Mitch., Common Sturgeon	4
	Serranidae	
	<i>Centropristus striatus</i> (L.), Sea Bass	2
	<i>Roccus lineatus</i> (Bloch), Striped Bass	1
	Sciaenidae	
	<i>Bairdella chrysura</i> (Lac.), Silver Perch	4
	<i>Leiostomus xanthurus</i> Lac., Spot	4
	<i>Micropogon undulatus</i> (L.), Croaker	1
	<i>Sciaenops ocellatus</i> (L.), Channel Bass	6
Biliary cirrhosis .22%	Siluridae	
	<i>Galeichthys felis</i> (L.), Sea Catfish	1
	Ephippidae	
	<i>Chaetodipterus faber</i> (Broussonet), Spadefish	1
Fatty degeneration of liver .22%	Serranidae	
	<i>Centropristus striatus</i> (L.), Sea Bass	2
Hepatitis, nematode infection .11%	Gadidae	
	<i>Urophycis chuss</i> (Walbaum), Squirrel Ling	1
Renal calculi .11%	Serranidae	
	<i>Mycteroperca bonaci</i> (Poey), Black Grouper	1
Kidney degeneration .54%	Serranidae	
	<i>Mycteroperca bonaci</i> (Poey), Black Grouper	1
	Ephippidae	
	<i>Chaetodipterus faber</i> (Broussonet), Spadefish	1
	Batrachoididae	
	<i>Opsanus tau</i> (L.), Toadfish	3
Ovarian degeneration .87%	Carchariidae	
	<i>Carcharias littoralis</i> (Mitch.), Sand Shark	1
	Aëtobatidae	
	<i>Rhinoptera quadriloba</i> (Le S.), Cow-nosed Ray	1
	Acipenseridae	
	<i>Acipenser oxyrinchus</i> Mitch., Common Sturgeon	3
	Serranidae	
	<i>Mycteroperca bonaci</i> (Poey), Black Grouper	3
Fatty degeneration, general .87%	Muraenidae	
	<i>Gymnothorax funebris</i> Ranzani, Green Moray	1

Fatty degeneration, general (continued)	Serranidae	
	<i>Epinephelus striatus</i> (Bloch), Nassau Grouper	3
	<i>Mycteroperca bonaci</i> (Poey), Black Grouper	2
	Lutianidae	
	<i>Lutianus griseus</i> (L.), Gray Snapper	2
Swim-bladder disorder 2.27%	Gadidae	
	<i>Gadus callarias</i> L., Cod	21
Gas aneurisym .54%	Sparidae	
	<i>Stenotomus chrysops</i> (L.), Porgy	1
	Sciaenidae	
	<i>Menticirrhus saxatilis</i> (B. & S.), Northern Kingfish	1
	Diodontidae	
	<i>Chilomycterus schoepfi</i> (Walbaum), Spiny Boxfish	2
	Triglidae	
	<i>Prionotus carolinus</i> (L.), Carolina Sea Robin	1
Malnutrition 4.65%	Syngnathidae	
	<i>Hippocampus hudsonius</i> ssp. De Kay, Seahorse	16
	<i>Hippocampus</i> sp., Long-nosed Seahorse	7
	Scaridae	
	<i>Pseudoscarus guacamaia</i> (Cuv.), Rain- bow Parrotfish	8
	<i>Scarus caeruleus</i> (Bloch), Blue Parrot- fish	9
	Monacanthidae	
	<i>Ceratacanthus schoepfi</i> (Walbaum), Orange Filefish	3
Trauma of eyes .43%	Ephippidae	
	<i>Chaetodipterus faber</i> (Broussonet), Spadefish	2
	Acanthyridae	
	<i>Acanthurus hepatus</i> (L.), Doctorfish	2
Exophthalmos .32%	Serranidae	
	<i>Centropristus striatus</i> (L.), Sea Bass	3
Tumor of thyroid 1.08%	Cyprinodontidae	
	<i>Cyprinodon variegatus</i> Lac., Sheepshead Minnow	10
Senility? .97%	Siluridae	
	<i>Galeichthys felis</i> (L.), Sea Catfish	2
	Muraenidae	
	<i>Gymnothorax funebris</i> Ranzani, Green Moray	2
	Carangidae	
	<i>Trachinotus glaucus</i> (Bloch), Palometa	1

	Labridae	
	<i>Halichaeres radiatus</i> (L.), Pudding-wife	1
	<i>Thalassoma bifasciatum</i> (Bloch), Bluehead	1
	Cichlidae	
	<i>Tilapia mossambica</i> Peters	1
	Diodontidae	
	<i>Diodon hystrix</i> L., Porcupine Fish	1
Fractured skull .32%	Galeidae	
	<i>Mustelus canis</i> (Mitch.), Smooth Dogfish	2
	Sciaenidae	
	<i>Cynoscion regalis</i> (B. & S.), Weakfish	1
Eaten by tankmates .22%	Pomacentridae	
	<i>Pomacentrus albofasciatus</i> Schl., Striped Pomacentrus	2
Jumped from tank .43%	Mugilidae	
	<i>Mugil cephalus</i> L., Mullet	1
	Ostraciidae	
	<i>Ostracion cornutus</i> (L.), East Indian Cowfish	1
	Scorpaenidae	
	<i>Pterois volitans</i> (Bennett), Zebra Fish	2
Fighting .54%	Muraenidae	
	<i>Gymnothorax funebris</i> Ranzani, Green Moray	1
	<i>Gymnothorax moringa</i> (Cuv.), Spotted Moray	1
	Pomacentridae	
	<i>Eupomacentrus leucostictus</i> (Müller & Troschel), Beau Gregory	3
Handling 1.41%	Syngnathidae	
	<i>Hippocampus h. hudsonius</i> De Kay, Northern Seahorse	11
	Ephippidae	
	<i>Chaetodipterus faber</i> (Broussonet), Spadefish	2
Destroyed .54%	Holocentridae	
	<i>Holocentrus ascensionis</i> (Osbeck), Squirrelfish	5
Water chemistry 11.3%	Ginglymostomidae	
	<i>Ginglymostoma cirratum</i> (Bonnaterre), Nurse Shark	2
	Galeidae	
	<i>Carcharhinus milberti</i> Müller & Henle, Ground Shark	1
	<i>Mustelus canis</i> (Mitch.), Smooth Dogfish	8
	Carchariidae	
	<i>Carcharias littoralis</i> (Mitch.), Sand Shark	1

Water chemistry (continued)	Rajidae		
	<i>Raja</i> spp., Rays		10
	Dasyatidae		
	<i>Dasyatis centrura</i> (Mitch.), Stingray		5
	Aëtobatidae		
	<i>Rhinoptera quadriloba</i> (Le S.), Cow-nosed Ray		10
	Muraenidae		
	<i>Gymnothorax funebris</i> Ranzani, Green Moray		1
	Syngnathidae		
	<i>Hippocampus h. hudsonius</i> De Kay, Northern Seahorse		30
	Carangidae		
	<i>Seriola zonata</i> (Mitch.), Rudderfish		14
	Serranidae		
	<i>Centropristus striatus</i> (L.), Sea Bass		20
	<i>Roccus lineatus</i> (Bloch), Striped Bass		2
<hr/>			
Unknown 4.44%	Megalopidae		
	<i>Tarpon atlanticus</i> (C. & V.), Tarpon		1
	Anguillidae		
	<i>Anguilla rostrata</i> (Le S.), Common Eel		1
	Mugilidae		
	<i>Mugil cephalus</i> L., Mullet		3
	Pleuronectidae		
	<i>Paralichthys dentatus</i> (L.), Fluke		3
	<i>Pseudopleuronectes americanus</i> (Walbaum), Winter Flounder		8
	Soleidae		
	<i>Achirus fasciatus</i> Lac., Hog Choker		3
	Cheilodipteridae		
	<i>Apogon maculatus</i> (Poey), Spotted Cardinal Fish		3
	Sciaenidae		
	<i>Eques acuminatus</i> (B. & S.), Cubby		4
	<i>Menticirrhus saxatilis</i> (B. & S.), Northern Kingfish		4
	Pomacentridae		
	<i>Amphiprion melanopus</i> Blkr., Anemone Fish		3
	Ostraciidae		
	<i>Lactophrys trigonus</i> (L.), Common Trunkfish		1
	Tetraodontidae		
<i>Tetraodon</i> sp., Pacific Puffer		1	
Scorpaenidae			
<i>Scorpaena madurensis</i> (C. & V.), Madeira Scorpion Fish		2	
Echeneididae			
<i>Echeneis naucrates</i> L., Sharksucker		4	

TABLE II.  
Causes of Mortality in Temperate Fresh-water Fishes.

DISEASE	FISH	No. DEATHS	
<i>Saprolegnia</i> sp. 6.66% <sup>1</sup>	Catostomidae		
	<i>Ictiobus bubalis</i> (Raf.), Buffalo Fish	7	
	<i>Moxostoma aureoleum</i> (Le S.), Redhorse Sucker	1	
	Siluridae		
	<i>Ameiurus nebulosus</i> (Le S.), Common Bullhead	5	
	<i>Ictalurus punctatus</i> (Raf.), Channel Cat	1	
<i>Ichthyophthirius multifiliis</i> Fouquet 45.3%	Salmonidae		
	<i>Salmo irideus</i> Gibbons, Rainbow Trout	1	
	Cyprinidae		
	<i>Campostoma anomalum</i> (Raf.), Stone- roller Minnow	2	
	<i>Ericymba buccata</i> Cope, Silver-mouthed Minnow	2	
	<i>Hybognathus</i> sp.	4	
	<i>Pimephales promelas</i> Raf., Fat-headed Minnow	1	
	<i>Semotilus atromaculatus</i> (Mitch.), Horned Chub	3	
	Siluridae		
	<i>Ictalurus punctatus</i> (Raf.), Channel Cat	80	
	Centrarchidae		
	<i>Ambloplites rupestris</i> (Raf.), Rock Bass	1	
	<i>Micropterus dolomieu</i> Lac., Small- mouthed Bass	1	
	<i>Cyclochaeta domerqui</i> Wallengren .47%	Centrarchidae	
		<i>Apomotis cyanellus</i> (Raf.), Green Sunfish	1
<i>Chilodon</i> sp. 1.43%	Centrarchidae		
	<i>Helioperca macrochira</i> (Raf.), Blue- nosed Sunfish	1	
	<i>Huro salmoides</i> (Lac.), Large-mouthed Bass	1	
	<i>Micropterus dolomieu</i> Lac., Small- mouthed Bass	1	
Protozoan, mixed infection 1.43%	Siluridae		
	<i>Ameiurus nebulosus</i> (Le S.), Common Bullhead	1	
	Centrarchidae		
	<i>Micropterus dolomieu</i> Lac., Small- mouthed Bass	2	
<i>Myxobolus</i> sp. .47%	Centrarchidae		
	<i>Chaenobryttus gulosus</i> (Cuv.), Warmouth	1	

<sup>1</sup> Percentage of total number of recorded deaths.

Gyrodactyloides (sp.?) .47%	Serranidae <i>Morone interrupta</i> Gill, Yellow Bass	8
<i>Argulus</i> sp. .47%	Lepisosteidae <i>Lepisosteus osseus</i> (L.), Long-nosed Gar	1
Cestode Enteritis .47%	Esocidae <i>Esox estor</i> Le S., Pike	1
Gastritis .47%	Amidae <i>Amia calva</i> L., Bowfin	1
Malnutrition .95%	Catostomidae <i>Catostomus commersonii</i> (Lac.), Common sucker <i>Hypentelium nigricans</i> (Le S.), Hog Sucker	1 1
Edema 2.38%	Cyprinidae <i>Carassius auratus</i> (L.), Goldfish <i>Scardinius erythrophthalmus</i> (L.), Pearl Roach Centrarchidae <i>Micropterus dolomieu</i> Lac., Small-mouthed Bass	2 2 1
Ovarian degeneration 2.38%	Acipenseridae <i>Scaphirhynchus platorhynchus</i> (Raf.), Shovel-nosed Sturgeon Salmonidae <i>Salvelinus fontinalis</i> (Mitch.), Brook Trout <i>Salvelinus fontinalis</i> (Mitch.), Albino Brook Trout Centrarchidae <i>Micropterus dolomieu</i> Lac., Small-mouthed Bass Percidae <i>Perca flavescens</i> (Mitch.), Yellow Perch	1 1 1 1
Myxomata? 6.19%	Salmonidae <i>Salmo fario</i> (Turton), Brown Trout <i>Salmo irideus</i> Gibbons, Rainbow Trout Centrarchidae <i>Helioperca macrochira</i> (Raf.), Blue-nosed Sunfish <i>Huro salmoides</i> (Lac.), Large-mouthed Bass <i>Micropterus dolomieu</i> Lac., Small-mouthed Bass	3 2 2 2 4
Epithelioma .47%	Salmonidae <i>Salvelinus fontinalis</i> (Mitch.), Albino Brook Trout	1
Scoliosis .47%	Acipenseridae <i>Scaphirhynchus platorhynchus</i> (Raf.), Shovel-nosed Sturgeon	1

Lordosis .47%	Acipenseridae <i>Acipenser fulvescens</i> Raf., Lake Sturgeon	1
Senility? 1.43%	Amiidae <i>Amia calva</i> L., Bowfin	1
	Centrarchidae <i>Helioperca macrochira</i> (Raf.), Blue-nosed Sunfish	1
	<i>Lepomis auritus</i> (L.), Red-breasted Sunfish	1
Chemical poisoning 5.24%	Esocidae <i>Esox masquinongy</i> Mitch., Muskellunge	11
Destroyed .47%	Cyprinidae <i>Chrosomus erythrogaster</i> Raf., Red-bellied Dace	1
Water temperature 13.3%	Salmonidae <i>Salmo irideus</i> Gibbons, Rainbow Trout	5
	<i>Salvelinus fontinalis</i> (Mitch.), Brook Trout	23
Unknown 5.24%	Salmonidae <i>Salmo salar sebago</i> Girard, Land-locked Salmon	2
	Cyprinidae <i>Cyprinus carpio</i> L., Carp	1
	<i>Rhinichthys atratulus</i> (Hermann), Black-nosed Dace	1
	Centrarchidae <i>Eupomotis gibbosus</i> (L.), Pumpkin Seed	4
	<i>Pomoxis sparoides</i> (Lac.), Calico Bass	2
	Percidae <i>Perca flavescens</i> (Mitch.), Yellow Perch	1

TABLE III

Causes of Mortality in Tropical Fresh-water Fishes.

DISEASE	FISH	No. DEATHS
<i>Saprolegnia</i> sp. 1.81% <sup>1</sup>	Gymnotidae <i>Electrophorus electricus</i> (L.), Electric Eel	4
	Symbranchidae <i>Symbranchus marmoratus</i> Bloch	1
<i>Ichthyophthirius multifiliis</i> Fouquet 1.81%	Characinidae <i>Cheirodon piaba</i> Lütken	5
Stregeid .36%	Toxotidae <i>Toxotes jaculator</i> (Pallas), Archerfish	1
Ovarian cysts .36%	Cyprinodontidae <i>Rivulus harti</i> Boulenger	1

<sup>1</sup> Percentage of total number of recorded deaths.

Failure to deliver young 2.53%	Poeciliidae			
	<i>Mollienisia sphenops</i> (C. & V.), Mollie		2	
	<i>Xiphophorus hellerii</i> Heckel, Swordtail		2	
	Swordtail X Platy Hybrid		3	
Egg bound 3.25%	Characinidae			
	<i>Copeina arnoldi</i> Regan, Splashing Salmlet		1	
	<i>Epicyrtus microlepis</i> Reinhardt, Glass Characin		1	
	<i>Hyphessobrycon bifasciatus</i> Ellis, Yellow Tetra		1	
	Gymnotidae			
	<i>Eigenmannia virescens</i> (Val.), Glass Gymnotid		1	
	<i>Gymnotus carapo</i> L., Banded Gymnotid		1	
	Cyprinidae			
	<i>Barbus conchoni</i> Ham-Buch., Rosy Barb		1	
	<i>Barbus cummingi</i> Gthr.		1	
	Cichlidae			
	<i>Aequidens moronii</i> Steindachner		1	
	<i>Geophagus surinamensis</i> (Bloch)		1	
	Hepatic degeneration .36%	Anabantidae		
		<i>Trichogaster trichopterus</i> (Pallas), Hairfin Gourami		1
Edema 2.17%	Cyprinidae			
	<i>Barbus conchoni</i> Ham.-Buch., Rosy Barb		1	
	Siluridae			
	<i>Acanthodoras cataphractus</i> (L.)		1	
	Anabantidae			
	<i>Betta splendens</i> Regan, Siamese Fighting Fish		1	
	<i>Macropodus cupanus</i> (C. & V.)		1	
	<i>Macropodus opercularis</i> (L.), Forked-tail Paradise Fish		1	
	Cichlidae			
	<i>Aequidens latifrons</i> (Steindachner)		1	
	Malnutrition 1.44%	Osteoglossidae		
		<i>Osteoglossum bicirrhosum</i> Vandelli, Arowana		1
		Poeciliidae		
		<i>Mollienisia velifera</i> Regan, Sailfin Mollie		1
		Cichlidae		
<i>Pterophyllum scalare</i> (C. & V.), Angel-fish			2	
Chemical poisoning, paint .72%		Gymnotidae		
<i>Sternopygus macrurus</i> (B. & S.)		2		
Jumped from tank 1.08%	Polypteridae			
	<i>Calamoichthys calabaricus</i> (Smith), Reedfish		1	



	Characinidae	
	<i>Exodon paradoxus</i> Müller & Troschel	1
	Siluridae	
	<i>Clarias</i> sp.	1
Senility? 7.58%	Polypteridae	
	<i>Calamoichthys calabaricus</i> (Smith), Reedfish	1
	Notopteridae	
	<i>Xenomystus nigri</i> Gthr., African Knife- fish	1
	Characinidae	
	<i>Hyphessobrycon flammeus</i> Myers, Flame Tetra	1
	<i>Hyphessobrycon heterorhabdus</i> (Ulrey)	1
	<i>Hyphessobrycon serpae</i> Durbin	1
	<i>Moenkhausia pittieri</i> Eigenmann	1
	<i>Mylossoma duriventris</i> (Cuv.)	1
	<i>Nannaethiops unitaeniatus</i> Gthr.	1
	<i>Pristella riddlei</i> (Meek)	1
	Gymnotidae	
	<i>Gymnotus coatesi</i> LaMonte, Tiger Knifefish	1
	Cyprinidae	
	<i>Barbus lineatus</i> Duncker	2
	<i>Esomus malayensis</i> E. Ahl, Malayan Flying Barb	1
	<i>Rasbora trilineata</i> Steindachner, Three- lined Rasbora	1
	Aspridinidae	
	<i>Bunocephalus bicolor</i> Steindachner	1
	Siluridae	
	<i>Acanthodoras</i> sp.	1
	Poeciliidae	
	<i>Belonesox belizanus</i> Kner, Pike-killie	1
	Anabantidae	
	<i>Ctenops vittatus</i> (C. & V.), Croaking Gourami	1
	Ophiocephalidae	
	<i>Channa asiatica</i> (L.), Snake-head	1
	Nandidae	
	<i>Badis badis</i> (Ham.-Buch.)	1
	Cichlidae	
	<i>Etroplus suratensis</i> (Bloch)	1
Missing 2.53%	Cyprinidae	
	<i>Rasbora trilineata</i> Steindachner, Three- lined Rasbora	1
	Cyprinodontidae	
	<i>Aphyosemion calliurum</i> (Boulenger), Lyretail	1
	Poeciliidae	
	<i>Belonesox belizanus</i> Kner, Pike-killie	2

Missing (continued)	Hemirhamphidae	
	<i>Dermogenys pusillus</i> van Hasselt, Fresh-water Halfbeak	1
	Anabantidae	
	<i>Helostoma temmincki</i> C. & V., Kissing Gourami	1
	Cichlidae	
	<i>Crenicichla lepidota</i> Heckel	1
Destroyed 1.81%	Siluridae	
	<i>Acanthodoras</i> sp.	1
	Loricariidae	
	<i>Loricaria</i> sp.	4
Water temperature 3.25%	Characinidae	
	<i>Creatochanes melanurus</i> (Bloch)	1
	Cyprinodontidae	
	<i>Fundulus chrysotus</i> Holbrook	1
	<i>Fundulus ocellaris</i> Jordan & Gilbert	1
	<i>Oryzias latipes</i> (Schl.), Medaka	1
	Cichlidae	
	<i>Cichlosoma severum</i> (Heckel), Deep-bodied cichlid	3
	<i>Herichthys cyanoguttatus</i> Baird and Girard	2
"Spoiled" water 4.70%	Dasyatidae	
	<i>Potamotrygon hystrix</i> (Müller & Troschel), Fresh-water Stingray	2
	Characinidae	
	<i>Nannaethiops unitaeniatus</i> Gthr.	2
	Cyprinidae	
	<i>Barbus semifasciatus</i> Gthr., Half-banded Barb	2
	Cyprinodontidae	
	<i>Rivulus harti</i> Boulenger	4
	Poeciliidae	
	<i>Micropoecilia branneri</i> Eigenmann	2
	Cichlidae	
	<i>Symphysodon discus</i> (Heckel), Disc Cichlid	1
Fighting 8.30%	Characinidae	
	<i>Copeina arnoldi</i> Regan, Splashing salmlet	1
	<i>Creatochanes melanurus</i> (Bloch)	1
	<i>Leporinus affinis</i> Gthr.	1
	<i>Leporinus fasciatus</i> (Bloch), Black-ringed Groundfish	1
	<i>Serrasalmus scapularis</i> Gthr.	1
	Gymnotidae	
	<i>Gymnotus carapo</i> L., Banded Gymnotid	1
	Cyprinodontidae	
	<i>Chriopeops goodei</i> (Jordan)	1

	<i>Epiplatys chaperi</i> (Sauvage), Chaper's Panchax	3
	<i>Panchax lineatus</i> C. & V., Striped Panchax	3
	Anabantidae	
	<i>Betta splendens</i> Regan, Siamese Fighting Fish	3
	<i>Macropodus opercularis</i> (L.), Fork-tailed Paradise Fish	3
	Cichlidae	
	<i>Cichlasoma cutteri</i> Fowler	1
	<i>Cichlasoma festivum</i> (Heckel), Painted Cichlid	1
	<i>Hemichromis bimaculatus</i> Gill, Ruby Jewel Fish	1
	<i>Hemichromis fasciatus</i> Peters	1
Acclimatization 23.1%	Osteoglossidae	
	<i>Osteoglossum bicirrhosum</i> Vandelli	2
	Mormyridae	
	<i>Mormyrus kannume</i> Forskål	1
	Characinidae	
	<i>Anoptichthys jordani</i> Hubbs & Innes, Blind Characin	20
	<i>Carnegiella strigata</i> (Gthr.), Mottled Hatchetfish	7
	<i>Chalceus macrolepidotus</i> Cuv.	1
	<i>Chilodus punctatus</i> Müller & Troschel, Head-standing Fish	1
	<i>Copeina arnoldi</i> Regan, Splashing salmlet	3
	<i>Corynopoma riisei</i> Gill	4
	<i>Gasteropelecus sternicla</i> (L.), Hatchetfish	3
	<i>Hemigrammus rhodostomus</i> E. Ahl, Red-mouthed Tetra	1
	<i>Pterodiscus laevis</i> , Eigenmann, Flying Characin	2
	Cyprinidae	
	<i>Rasbora pauciperforata</i> Weber & de Beaufort	3
	Callichthyidae	
	<i>Corydoras</i> sp.	1
	Cyprinodontidae	
	<i>Aphyosemion calliurum</i> (Boulenger), Lyretail	2
	Atherinidae	
	<i>Telmatherina ladigesii</i> E. Ahl	8
	Cichlidae	
	<i>Cichlasoma cutteri</i> Fowler	1
	Gobiidae	
	<i>Boleophthalmus viridus</i> Ham.-Buch.	4
Unknown 32.8%	Mormyridae	
	<i>Mormyrus kannume</i> Forskål	1

Unknown  
(continued)

	Pantodontidae	
	<i>Pantodon buchholzi</i> Peters, Fresh-water Butterflyfish	1
	Characinidae	
	<i>Anostomus plicatus</i> Eigenmann	1
	<i>Carnegiella strigata</i> (Gthr.), Mottled Hatchetfish	1
	<i>Chalcinus elongatus</i> Gthr.	1
	<i>Chalcinus rotundatus</i> (Schomburk)	1
	<i>Epicyrthus microlepis</i> Reinhardt, Glass Characin	2
	<i>Hemiodus gracilis</i> Gthr.	1
	<i>Hemiodus quadrimaculatus</i> Pellegrin	1
	<i>Hyphessobrycon innesi</i> Hubbs, Neon Tetra	2
	<i>Myloplus schomburgkii</i> (Jardine)	2
	<i>Poecilobrycon eques</i> (Steindachner)	1
	<i>Poecilobrycon trifasciatus</i> (Steindachner), Three-lined Pencilfish	2
	<i>Poecilobrycon unifasciatus</i> (Steindachner), One-lined Pencilfish	1
	<i>Prochilodus insignis</i> Schomburgk, Flag-tail	1
	Cyprinidae	
	<i>Barbus conchoniensis</i> Ham.-Buch., Rosy Barb	2
	<i>Barbus oligolepsis</i> (Bleeker)	1
	<i>Barbus phutunio</i> (Ham.-Buch.)	1
	<i>Barbus</i> sp.	5
	<i>Danio malabaricus</i> (Jerdon), Giant Danio	1
	<i>Notropis metallicus</i> Jordan & Meek	3
	<i>Rasbora heteromorpha</i> Duncker, Red Rasbora	1
	<i>Rasbora maculata</i> Duncker	2
	Cobitidae	
	<i>Botia</i> sp.	1
	Siluridae	
	<i>Centromochlus aulopygius</i> Kner	1
	<i>Microglanis parahybae</i> (Steindachner)	1
	Callichthyidae	
	<i>Corydoras arcuatus</i> Ahl	1
	<i>Corydoras leopardus</i> Myers	
	<i>Corydoras melanisteus</i> Regan	1
	Loricariidae	
	<i>Loricaria parva</i> Boulenger	1
	<i>Plecostomus</i> sp.	1
	Cyprinodontidae	
	<i>Chriopeops goodei</i> (Jordan)	1
	<i>Panchax lineatus</i> C. & V., Striped Panchax	1
	Poeciliidae	
	<i>Belonesox belizanus</i> Kner, Pike-killie	1
	<i>Limia nigrofasciata</i> Regan	1
	<i>Limia vittata</i> (Guichenot)	1
	<i>Mollienisia latipinna</i> Le S., Mudpusser	2
	<i>Phalloceros caudomaculatus</i> (Hensel)	4
	<i>Platypoecilus maculatus</i> Gthr., Platy	10
	<i>Quintana atrizona</i> Hubbs	1

Hemirhamphidae	
<i>Dermogenys pusillus</i> van Hasselt, Fresh-water Halfbeak	1
Anabantidae	
<i>Colisa lalia</i> (Ham.-Buch.), Dwarf Gourami	2
<i>Ctenops vittatus</i> (C. & V.), Croaking Gourami	4
<i>Macropodus opercularis</i> (L.), Fork-tailed Paradise Fish	3
Nandidae	
<i>Badis badis</i> (Ham.-Buch.)	1
<i>Monocirrhus polyacanthus</i> Heckel, Leaf-fish	4
<i>Polycentrus schomburgkii</i> Müller and Troschel, Casarab	1
Centrarchidae	
<i>Elassoma evergladei</i> Jordan, Pigmy sunfish	2
Cichlidae	
<i>Apistogramma pertense</i> , (Haseman), Dwarf Cichlid	1
<i>Apistogramma</i> sp.	1
<i>Etroplus maculatus</i> (Bloch), Orange Chromide	2
<i>Geophagus jurupari</i> Heckel, Demon Fish	1
<i>Geophagus surinamensis</i> (Bloch)	1
<i>Tilapia zillii</i> Gervais	1
Toxotidae	
<i>Toxotes jaculator</i> (Pallas), Archerfish	1

TABLE IV.

Causes of Deaths in Specimens Other Than Fishes.

DISEASE	AMPHIBIANS	No. DEATHS
Fungus	<i>Cryptobranchus alleganiensis</i> (Daudin), Hellbender	2
	<i>Necturus maculosus</i> (Raf.), Mudpuppy	5
	<i>Proteus anguinus</i> , olm	2
Red-leg disease <i>Proteus hydrophilus</i> (Sanarelli)	<i>Pipa surinamensis</i> , Surinam Toad	1
Myxoma	<i>Necturus maculosus</i> (Raf.), Mudpuppy	2
REPTILES		
Fungus 6.1% <sup>1</sup>	<i>Alligator mississippiensis</i> (Daudin), American Alligator	5
	<i>Chelys fimbriata</i> , Matamata	1
Liver abcess from nematodes 1.0%	<i>Natrix s. sipedon</i> (L.), Common Water Snake	1
Liver degeneration 1.0%	Guatemalan Turtle	1

<sup>1</sup> Percentage of total number of recorded deaths.

Fatty degeneration 7.1%	<i>Alligator mississippiensis</i> (Daudin), American Alligator	7
Malnutrition 6.1%	<i>Caiman jacuare</i> (Daudin) <i>Caiman sclerops</i> (Schneider) <i>Gecko</i> sp.	1 4 1
Enteritis 56.5%	<i>Caretta caretta</i> (L.), Loggerhead Turtle <i>Chrysemys picta</i> (Schneider), Painted Turtle <i>Clemmys guttata</i> (Schneider), Spotted Turtle <i>Clemmys insculpta</i> (Le Conte), Wood Turtle <i>Graptemys p. pseudogeographica</i> (Gray), Mississippi Map Turtle <i>Podochemis expansa</i> , Amazon River Turtle <i>Pseudemys scripta troostii</i> (Holbrook), Cumberland Turtle <i>Pseudemys scripta</i> ssp., Yellow-bellied Terrapin <i>Terrapene carolina</i> (L.), Box turtle <i>Trionyx</i> sp. Chinese River Turtle	1 23 6 6 1 1 8 1 7 1 1
Floating trouble? 1.0%	<i>Caretta caretta</i> (L.), Loggerhead Turtle	1
Fighting 2.0%	<i>Caiman sclerops</i> (Schneider) <i>Caretta caretta</i> (L.), Loggerhead Turtle	1 1
Drowned 7.1%	<i>Alligator mississippiensis</i> (Daudin), American Alligator <i>Trionyx ferox</i> (Schneider), Southern Soft-shelled Turtle	6 1
Unknown 12.1%	<i>Caiman niger</i> Spix <i>Caretta caretta</i> (L.), Loggerhead Turtle <i>Caretta kempii</i> (Garman), Kemp's Turtle <i>Chelys fimbriata</i> , Matamata <i>Emys blandingii</i> (Holbrook), Blanding's Turtle <i>Graptemys geographica</i> (Le S.), Map Turtle <i>Malaclemys centrata</i> (Latreille), Diamond-back Terrapin <i>Macrochelys temminckii</i> (Troost), Alligator Snapping Turtle <i>Podochemis expansa</i> , Amazon River Turtle <i>Terrapene carolina</i> (L.), Box Turtle <i>Trionyx</i> sp. East Indian Mud Turtle	1 1 1 1 1 1 1 1 1 1 1 1 1

## BIRDS

Tuberculosis?	<i>Spheniscus demersus</i> (L.), Blackfoot Penguin	2
Fractured leg, Gangrene	<i>Spheniscus humboldti</i> Meyen, Humboldt's Penguin	1

MAMMAL		
Malnutrition	<i>Trichechus inunguis</i> Natterer, Amazon Manatee	1
INVERTEBRATES		
Larval trematodes on gills	<i>Scyllarides latus</i> , Flat Lobster	1
Fighting	<i>Octopus</i> sp.	3
Water chemistry	<i>Fasciolaria gigantea</i> Kiener, Giant Band Shell <i>Fasciolaria tulipa</i> L., Tulip Band Shell <i>Limulus polyphemus</i> (L.), Horseshoe Crab <i>Calappa flammea</i> (Herbst), Queen Crab <i>Libinia dubia</i> Milne-Edwards, Spider Crab <i>Menippe mercenaria</i> (Say), Stone Crab <i>Panulirus argus</i> (Latreille), Spiny Lobster <i>Petrochirus bahamensis</i> , Sea-soldier <i>Squilla empusa</i> , Mantis Shrimp <i>Oreaster reticulatus</i> , Giant Starfish <i>Sargartia leucolena</i> , White Anemone	1 1 10 2 7 2 1 1 1 10 35
Unknown	<i>Cambarus</i> sp., Fresh-water Crayfish <i>Homarus americanus</i> Milne-Edwards, Northern Lobster Papaloapan Fresh-water Crab	5 2 1

TABLE V.

Summary of Mortality Percentage by Causes.

Causes	Marine	Fresh-water temperate	Fresh-water tropical	Amphibians	Reptiles	Birds	Mammals	Invertebrates
Infectious disease .....	64.8	60.5	3.9	83.3	1.0	67	0	1.2
Non-infectious disease .....	19.5	21.0	32.2	16.7	86.9	33	100	3.6
Water conditions <sup>1</sup> .....	11.3	13.3	31.1	0	0	0	0	85.5
Unknown .....	4.4	5.2	32.8	0	12.1	0	0	9.7

<sup>1</sup> Includes density, temperature, pH. and chemical composition.

TABLE VI.  
Summary of Mortality Percentage by Months.

	<i>Marine</i>	<i>Fresh-water temperate</i>	<i>Fresh-water tropical</i>	<i>Total</i>	<i>Amphibians</i>	<i>Reptiles</i>	<i>Birds</i>	<i>Mammals</i>	<i>Invertebrates</i>
January .....	2.7	0	7.6	3.4	8.3	3.0	0	0	2.4
February .....	4.6	2.9	5.4	4.5	0	5.1	33.3	0	1.2
March .....	4.3	0	12.3	5.2	0	11.1	0	0	0
April .....	5.1	1.0	8.7	5.2	8.3	6.1	0	0	3.6
May .....	7.2	6.7	15.5	8.8	8.3	21.2	33.3	0	1.2
June .....	8.4	3.3	5.8	7.1	0	5.1	0	0	1.2
July .....	35.5	16.2	16.6	28.9	0	12.1	0	0	7.2
August .....	12.4	3.3	6.6	9.9	0	6.1	0	100	30.1
September .....	6.7	2.9	7.6	6.2	16.7	10.1	0	0	9.6
October .....	5.6	4.3	4.3	5.2	16.7	3.0	0	0	13.2
November .....	4.1	25.7	5.4	7.6	0	5.1	0	0	18.1
December .....	3.5	33.8	4.3	8.1	41.7	12.1	33.3	0	12.1

TABLE VII.  
Summary of Mortality Percentage of Fishes by Sex.

	<i>Marine</i>	<i>Fresh-water temperate</i>	<i>Fresh-water tropical</i>	<i>Total</i>
Male .....	27.9	14.8	23.5	25.1
Female .....	37.2	39.0	35.0	37.0
Immature .....	5.9	40.5	9.4	11.8
Undetermined .....	29.0	5.7	32.1	26.1

TABLE VIII.  
Longevity of Specimens which Died During 1939.

<i>Longevity</i>	<i>% of 925 marine fishes</i>	<i>% of 210 fresh-water temperate fishes</i>	<i>% of 277 fresh-water tropical fishes</i>	<i>% average of all fishes</i>	<i>% of 12 amphibians</i>	<i>% of 99 reptiles</i>	<i>% of 3 birds</i>	<i>% of one mammal</i>	<i>% of 83 invertebrates</i>
Unknown .....	—	—	6.9	1.3	—	—	—	—	—
One month or less.....	55.5	27.6	22.0	44.8	0	9.1	33.3	100.	12.0
Two to twelve months.....	39.3	60.0	50.2	44.5	100.	87.9	0	0	88.0
More than one year.....	5.2	12.4	20.9	9.4	0	3.0	66.7	0	0



TABLE IX.

Fishes Over Two Years Old which Died During 1939.<sup>1</sup>

## MARINE

## Ten Years

*Gymnothorax funebris* Ranzani, Green Moray

## Seven Years

*Tilapia mossambica* Peters

## Six Years

*Ginglymostoma cirratum* (Bonnaterre),

Nurse Shark

## Five Years

*Trachinotus glaucus* (Bloch), Palmoneta*Sciaenops ocellatus* (Linnaeus), Channel

Bass

*Mycteroperca bonaci* (Poey), Black Grouper

## Four Years

*Acipenser oxyrinchus* Mitchill, Common

Sturgeon

*Galeichthys felis* (Linnaeus), Sea Catfish*Gymnothorax moringa* (Cuvier), Spotted

Moray

*Seriola zonata* (Mitchill), Rudder-fish*Pogonias cromis* (Linnaeus), Sea Drum*Halieuaeres radiatus* (Linnaeus), Pudding-

wife

*Thalassoma bifasciatum* (Bloch), Blue-head

## Three Years

*Tarpon atlanticus* (Cuvier & Valenciennes),

Tarpon

*Roccus lineatus* (Bloch), Striped Bass*Scatophagus argus* (Bleeker), Scat

## Two Years

*Epinephelus striatus* (Bloch), Nassau

Grouper

*Rypticus saponaceus* (Bloch & Schneider),

Soapfish

*Dasyllus aruanus* (Linnaeus), Jesuite*Chaetodipterus faber* (Broussonet), Spade-

fish

*Balistes vetula* Linnaeus, Queen Triggerfish*Diodon hystrix* Linnaeus, Porcupine Fish

## TEMPERATE FRESH-WATER

## Six Years

*Lepisosteus osseus* (Linnaeus), Long-nosed

Gar

*Amia calva* Linnaeus, Bowfin

## Five Years

*Acipenser fulvescens* Rafinesque, Lake

Sturgeon

*Huro salmoides* (Lacépède), Large-mouthed

Bass

*Morone interrupta* Gill, Yellow Bass

## Four Years

*Scaphirhynchus platorhynchus* (Rafinesque),

Shovel-nosed Sturgeon

*Esox masquinongy* Mitchill, Muskellunge*Ambloplites rupestris* (Rafinesque), Rock

Bass

*Lepomis auritus* (Linnaeus), Red-breasted

Sunfish

*Helioperca macrochira* (Rafinesque), Blue-

nosed Sunfish

## Three Years

*Scardinius erythrophthalmus* (Linnaeus),

Pearl Roach

*Ameiurus nebulosus* (Le Sueur), Common

Bullhead

*Perca flavescens* (Mitchill), Yellow Perch

## Two Years

*Salvelinus fontinalis* (Mitchill), Albino

Brook Trout

*Pomoxis sparoides* (Lacépède), Calico Bass

## TROPICAL FRESH-WATER

## Six and One-half Years

*Channa asiatica* (Linnaeus), Snake-head

## Five Years

*Hyphessobrycon heterorhabdus* (Ulrey)*Hyphessobrycon serpae* Durbin*Pristella riddlei* (Meek)*Serrasalmus scapularis* Günther

## Four Years

*Moenkhausia pittieri* Eigenmann*Gymnotus coatesi* LaMonte, Tiger Knifefish*Ctenopoma vittatus* (Cuvier & Valenciennes),

Croaking Gourami

*Acuicentrus moronii* Steindachner

## Three Years

*Calamoichthys calabaricus* (Smith), Reedfish*Esomus malayensis* E. Ahl, Malayan Flying

Barb

*Rasbora trilineata* Steindachner, Three-lined

Rasbora

*Epiplatys suratensis* (Bloch)

## Two and One-half Years

*Xenomystus nigri* Günther, African Knife-

fish

*Barbus lineatus* Duncker

## Two Years

*Mylossoma duriventris* (Cuvier)*Cheirodon piaba* Lütken*Rasbora heteromorpha* Duncker, Red Rasbora*Rasbora maculata* Duncker*Bunocephalus bicolor* Steindachner*Acanthodoras* sp.*Centromochlus aulopygius* Kner*Microglanis parahybae* (Steindachner)*Badis badis* (Hamilton-Buchanan)*Cichlasoma festivum* (Heckel), Painted

Cichlid

*Herichthys cyanoguttatus* Baird & Girard*Symbranchus marmoratus* Bloch<sup>1</sup> Includes only oldest specimen of each species.

TABLE X.  
Parasites and Hosts Observed in 1939.<sup>1</sup>

Parasite	Host	Site of Infection
I. Protozoa		
A. Marine species		
1. <i>Protrichomonas</i> sp.	<i>Chilomycterus schoepfii</i> (Walbaum)	Intestine
2. <i>Oodinium ocellatum</i> Brown	Marine fishes	Gills
3. <i>Trichodina</i> sp.	Marine fishes	Gills
B. Fresh-water species		
4. <i>Cyclochaeta domerqui</i> Wallengren	Fresh-water fishes	Skin & gills
5. <i>Chilodon</i> sp.	Fresh-water fishes	Skin & gills
6. <i>Ichthyophthirius multiliis</i> Fouquet	Fresh-water fishes	Skin & gills
7. <i>Henneguya ameiurensis</i> <sup>2</sup> Nigrelli & Smith	<i>Ameiurus nebulosus</i> (Le Sueur)	Skin
8. <i>Mycobolus</i> sp.	<i>Chaenobryttus gulosus</i> (Cuvier)	Gills
II. Trematoda, monogenetic		
A. Marine species		
9. <i>Epibdella melleni</i> MacCallum	Marine fishes	Skin & eyes
10. <i>Microcotyle</i> sp.	Marine fishes	Gills
11. <i>Diplectanus</i> sp.	Marine fishes	Gills
12. <i>Gyrodactyloides</i> (Spp?)	<i>Fundulus heteroclitus</i> (Linnaeus)	Skin & gills
B. Fresh-water species		
13. <i>Gyrodactyloides</i> (Spp?)	Fresh-water fishes	Skin & gills
III. Trematoda, digenetic adults		
A. Marine species		
14. <i>Lintonium vibex</i> (Linton)	<i>Spheroides maculatus</i> (Bloch & Schneider)	Pharynx
15. <i>Bianium plicatum</i> (Linton)	<i>Spheroides maculatus</i> (Bloch & Schneider)	Intestine
16. <i>Probiotrema</i> sp.	<i>Amphotistius sabinus</i> (Le Sueur)	Body cavity
17. <i>Tubulovesicula madurensis</i> <sup>3</sup> Nigrelli	<i>Scorpaena madurensis</i> (Cuvier & Valenciennes)	Stomach
18. Hemiuroidae (Spp?)	Marine fishes	Stomach
19. <i>Podocotyle atzi</i> Nigrelli <sup>3</sup>	<i>Scorpaena madurensis</i> (Cuvier & Valenciennes)	Intestine
20. Allocreadiidae (Spp?)	Marine fishes	Intestine
21. <i>Nematobothrium</i> sp.	<i>Sarda sarda</i> (Bloch)	Gills
22. <i>Sterrhurus branchialis</i> Stunkard & Nigrelli	<i>Trichiurus lepturus</i> Linnaeus	Gills
B. Fresh-water species		
23. <i>Allacanthochoasmus varius</i> Vanceleave	<i>Morone interrupta</i> Gill	Intestine
24. <i>Allacanthochoasmus artus</i> Vanceleave & Mueller	<i>Morone interrupta</i> Gill	Intestine
25. <i>Neochasmus umbellus</i> Vanceleave & Mueller	<i>Morone interrupta</i> Gill	Intestine
26. <i>Bucephalus pusillus</i> (Stafford)	<i>Stizostedion vitreum</i> (Mitchill)	Intestine
27. <i>Allocreadium</i> sp.	<i>Eupomotis gibbosus</i> (Linnaeus)	Intestine
28. <i>Crepidostomum</i> sp.	<i>Helioperca macrochira</i> (Rafinesque)	Intestine
29. Amphistome (Sp?)	<i>Trichechus manatus latirostrus</i> (Harlan)	Caecum

<sup>1</sup> Including species and specimens not on exhibition at the N. Y. Aquarium.

<sup>2</sup> See Nigrelli & Smith, 1940

<sup>3</sup> See Nigrelli, 1940b.

## IV. Trematoda, digenetic larvae

## A. Marine fishes

30. *Cryptocotyle lingua* (Creplin) *Tautoga onitis* (Linnaeus) Encysted on skin & fins  
 31. Metacercaria (Sp?) *Scyllarides latus* Encysted on gills

## B. Fresh-water species

32. *Neascus vancleavei* (Agersbord) Fresh-water fishes Organs  
 33. *Clinostomum complanatum* (Rudolphi) Fresh-water fishes Skin

## V. Cestoda, adults

## A. Marine species

34. *Calliobothrium verticillatum* (Rudolphi) *Mustelus canis* (Mitchill) Intestine  
 35. *Crossobothrium laciniatum* Linton *Carcharias littoralis* (Mitchill) Intestine

## B. Fresh-water species

36. *Proteocephalus* sp. *Huro salmoides* (Lacépède) Intestine  
 37. *Proteocephalus pinguis* LaRue *Esox estor* Le Sueur Intestine  
 38. *Corallobothrium* sp. *Ictalurus punctatus* (Rafinesque) Intestine  
 39. *Bothriocephalus cuspidatus* Cooper *Perca flavescens* (Mitchill) Intestine

## VI. Cestoda, larvae

## A. Marine species

40. *Otobothrium crenacolle* Linton *Poronotus tricanthus* (Peck) Encysted around vertebrae  
 41. Tetrarhynchid forms Marine fishes Intestine  
 42. Tetrarhynchid forms Groupers Encysted in body cavity

## B. Fresh-water species

43. *Ligula intestinalis* (Goeze) *Hyborhynchus notatus* (Rafinesque) Intestine

## VII. Nematoda

## A. Fresh-water species

44. *Camallanus* sp. Fresh-water fishes Intestine  
 45. *Spinitectis* sp. *Micropterus dolomieu* Lacépède Intestine

## VIII. Hirudinea

## A. Marine species

46. *Branchellion ravenelli*<sup>4</sup> (Girard) *Dasyatis hastatus* (De Kay) Skin  
 47. *Pontobdella muricata* (Linnaeus) *Sphyrna zygaena* (Linnaeus) Skin

## B. Fresh-water species

48. *Placobdella parasitica* (Say) Fresh-water turtles Skin

## IX. Copepoda

## A. Marine species

49. *Sphyrion lumpi* (Krøyer) *Sebastes marinus* (Linnaeus) Body  
 50. *Chondranchopsis nodosus* (Muller) *Sebastes marinus* (Linnaeus) Gills  
 51. *Penella instructa* Wilson *Xiphias gladius* Linnaeus Body  
 52. *Ergasilidae* (Spp?) Marine fishes Gills  
 53. *Pandarus bicolor* Leach *Mustelus canis* (Mitchill) Skin  
 54. *Lernaenicus radiatus* (Le Sueur) *Menidia menidia* (Linnaeus) Body

<sup>4</sup> See Meyer, 1939.

## B. Fresh-water species

55. <i>Lernae</i> sp.	<i>Carassius auratus</i> (Linnaeus)	Body
56. <i>Argulus</i> spp.	Fresh-water fishes	Skin
57. <i>Ergasilus</i> sp.	Fresh-water fishes	Gills

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## EXPLANATION OF THE PLATES.

All photographs by S. C. Dunton of the New York Aquarium.

- Figs. 1 and 2. Queen triggerfish, showing peculiar ulceration of the skin around the mouth and fins. The causative agent is unknown.
- Fig. 3. Edematous condition in pearl roach. A general anasarca was present and the kidneys were completely degenerated.
- Fig. 4. Viscera of small-mouthed bass, showing ovarian degeneration. This condition results from the failure to spawn and to resorb the eggs.
- Fig. 5. Portion of intestine of pike with heavy infestation of *Proteocephalus pinguis*. This infection was acquired in the wild state, since the fish lived but two months in captivity. The entire intestine was practically filled with these cestodes. Note the severe hemorrhage produced.
- Fig. 6. Intestine of blue-nosed sunfish with hemorrhagic islands caused by intestinal flukes. Not included in Table II.
- Fig. 7. Transverse section of alligator tail showing fatty degeneration. Large fat masses have pushed aside the muscles. Within these masses may be seen numbers of dark areas, consisting of hard, granular, yellowish material.